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(54) **INDUCTION FIXING DEVICE WITH
MAGNETIC MEMBER INCLUDING A MESH
PART**

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G03G 2215/2003 (2013.01)

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15/2007; **G03G 15/2017**; **G03G 15/2053**;
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See application file for complete search history.

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(57) **ABSTRACT**

According to one embodiment, a fixing device includes a fixing belt, an induction current generating part and an auxiliary heat generation part. The fixing belt includes a conductive layer. The induction current generating part faces the fixing belt in a thickness direction. The induction current generating part heats the conductive layer by electromagnetic induction. The auxiliary heat generation part faces the induction current generating part through the fixing belt. The auxiliary heat generation part includes a magnetic member. The magnetic member includes a mesh part. The mesh part has a mesh shape when viewed from the thickness direction of the fixing belt.

12 Claims, 8 Drawing Sheets

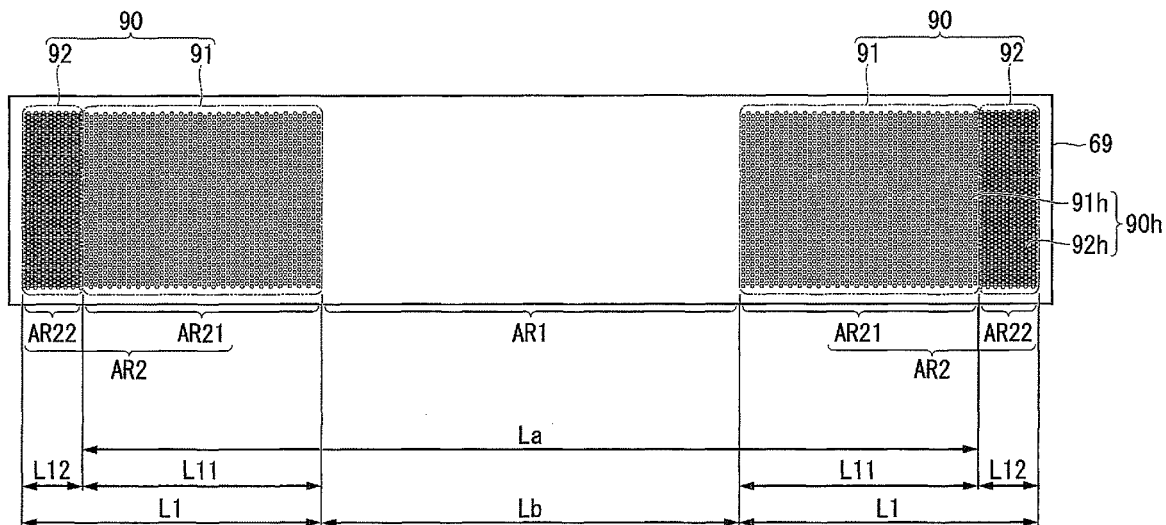
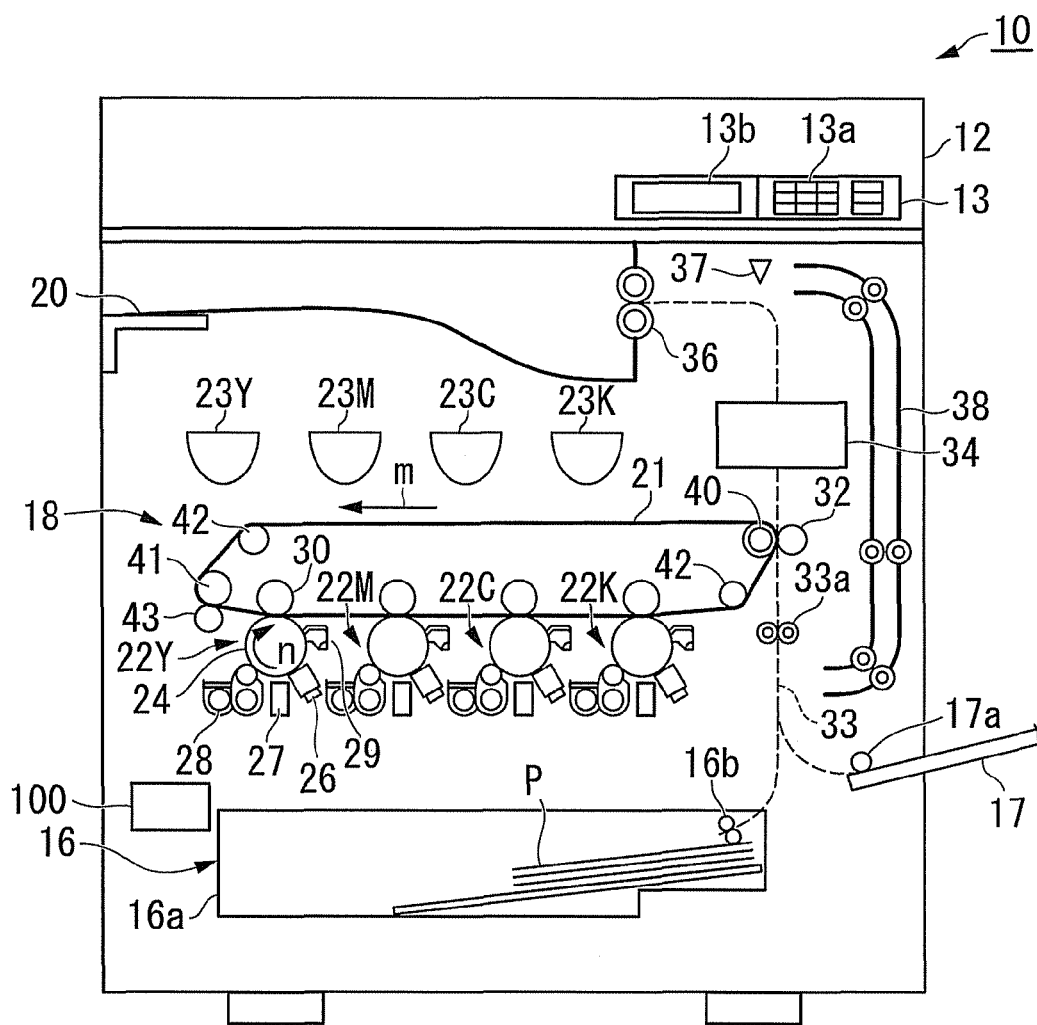
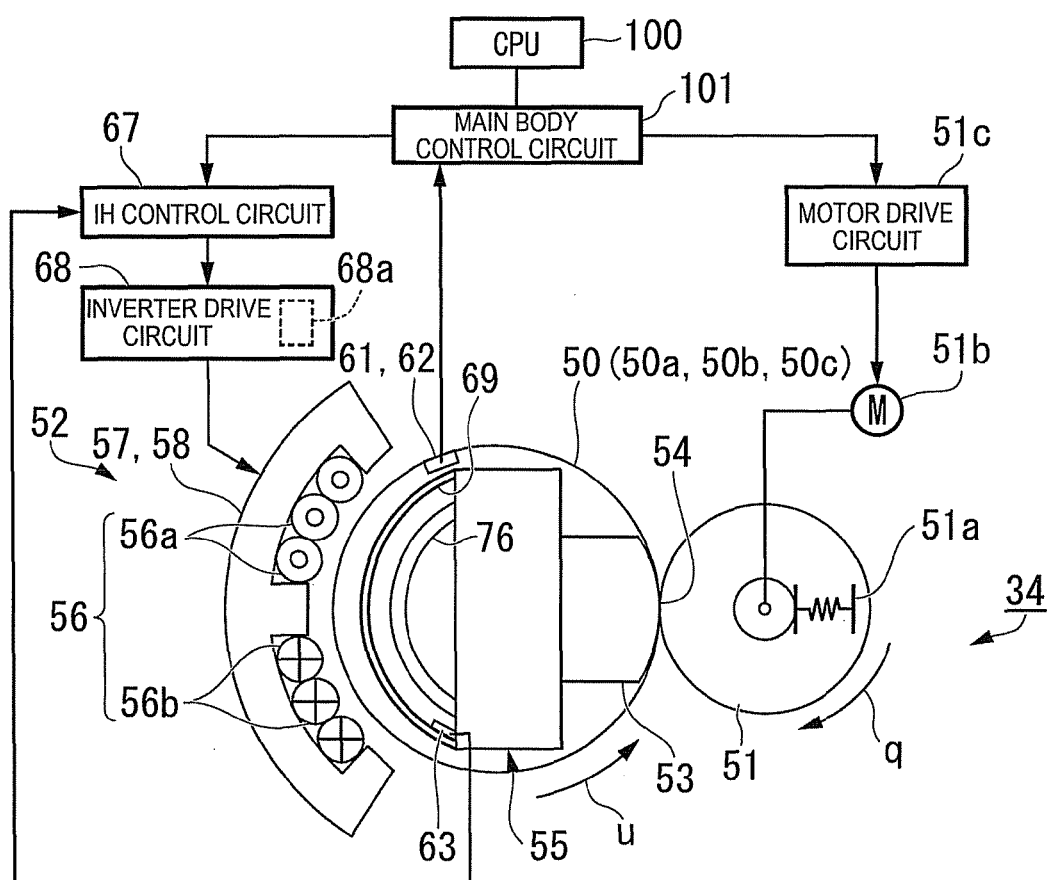


FIG. 1





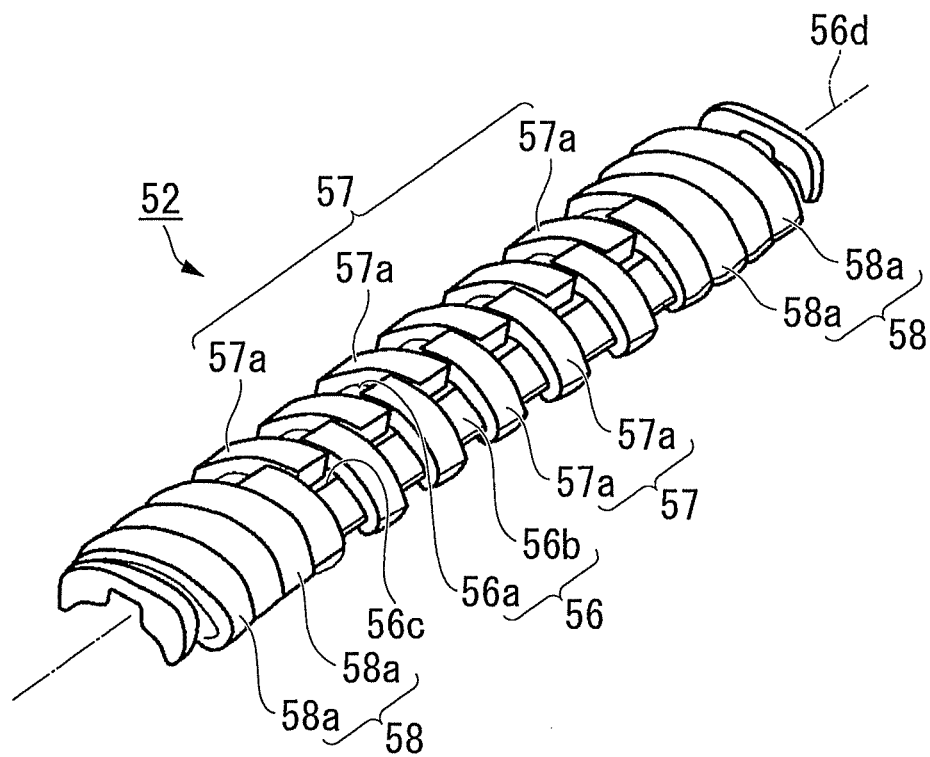


FIG. 4

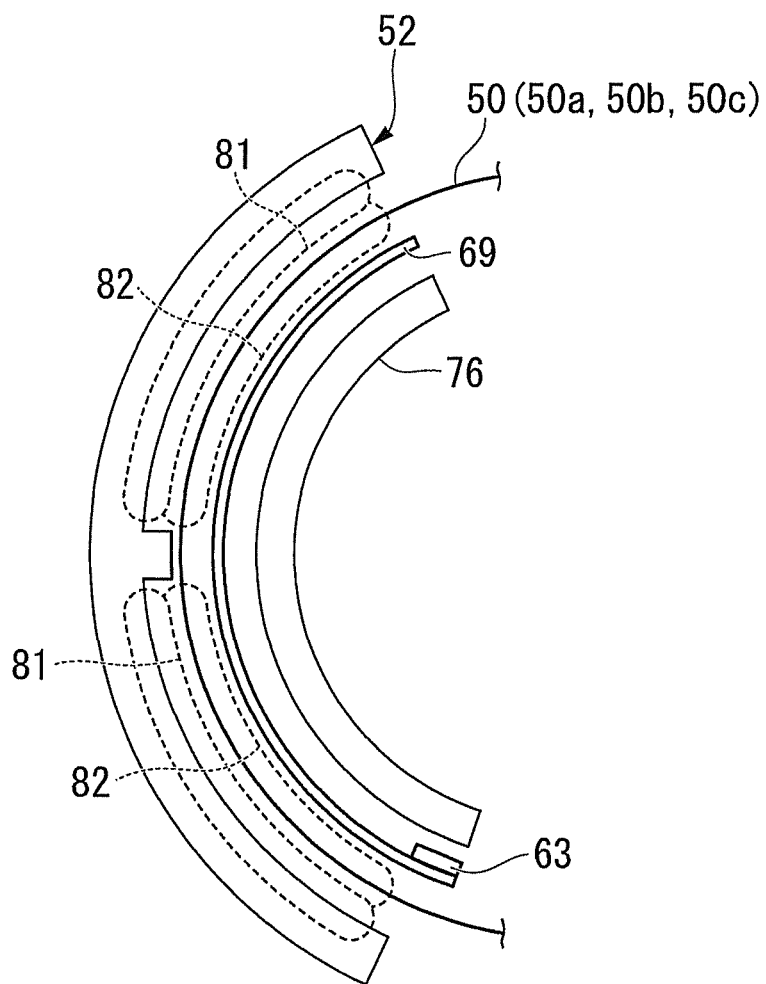


FIG. 5

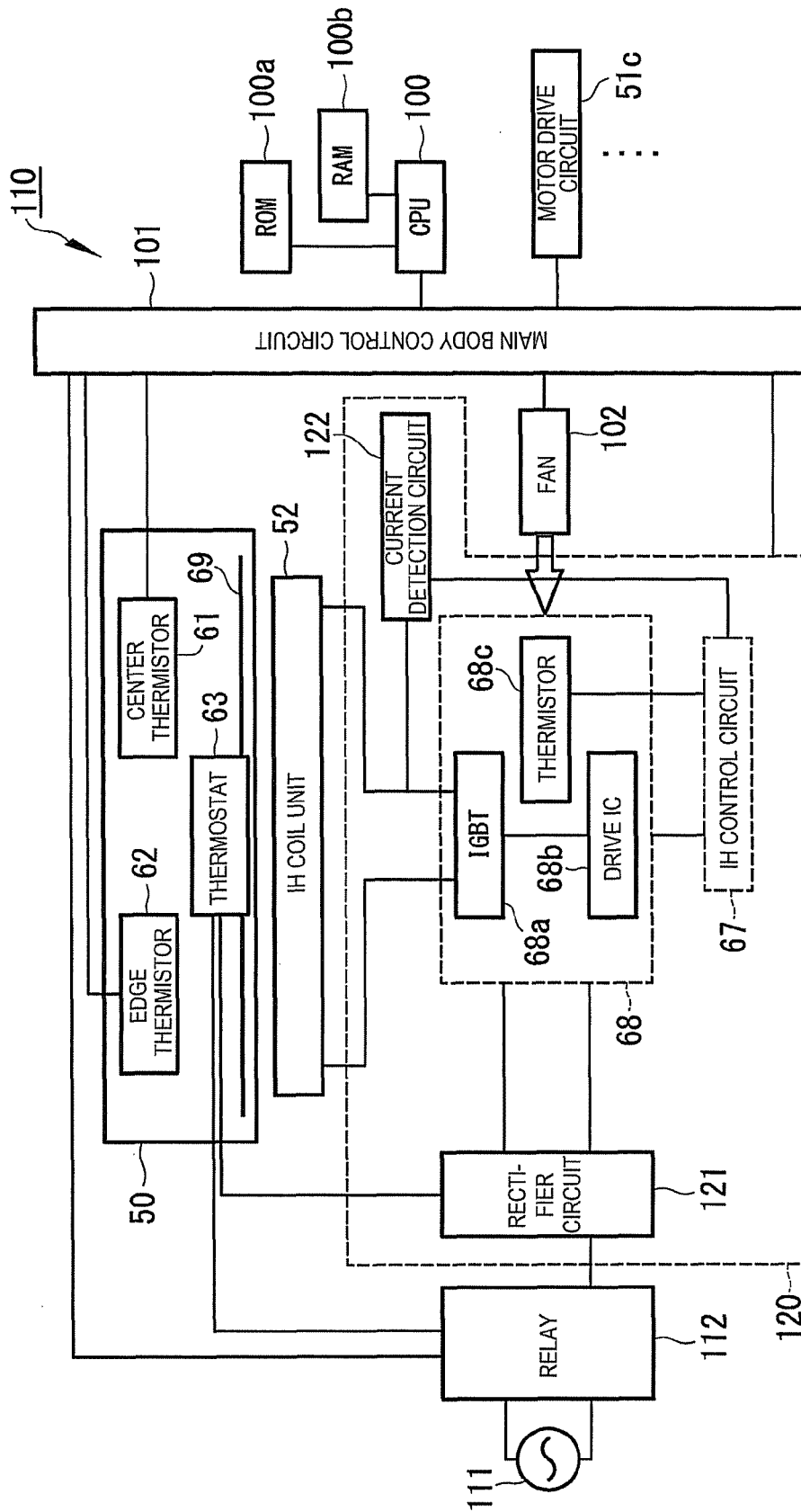


FIG. 6

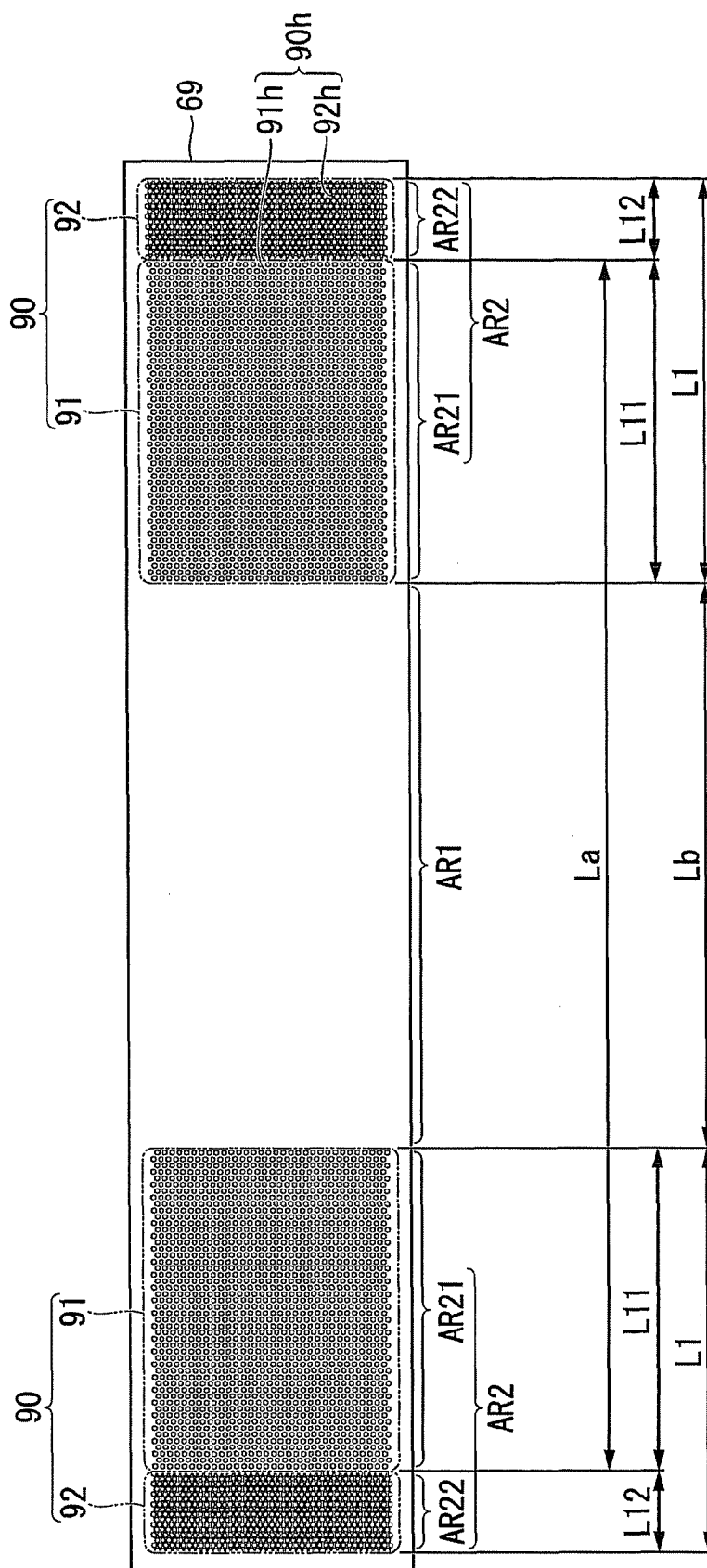


FIG. 7

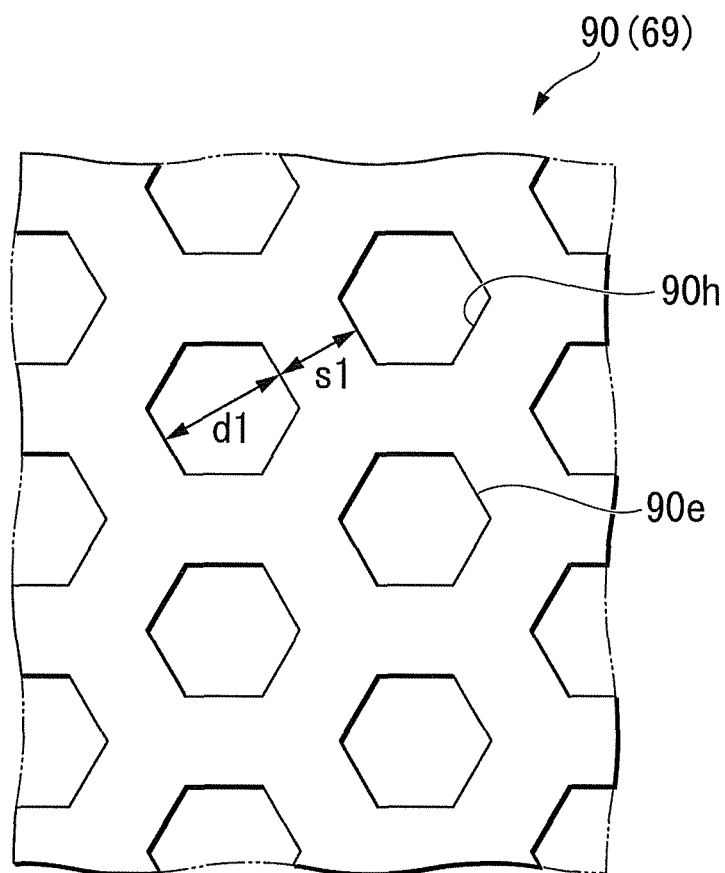
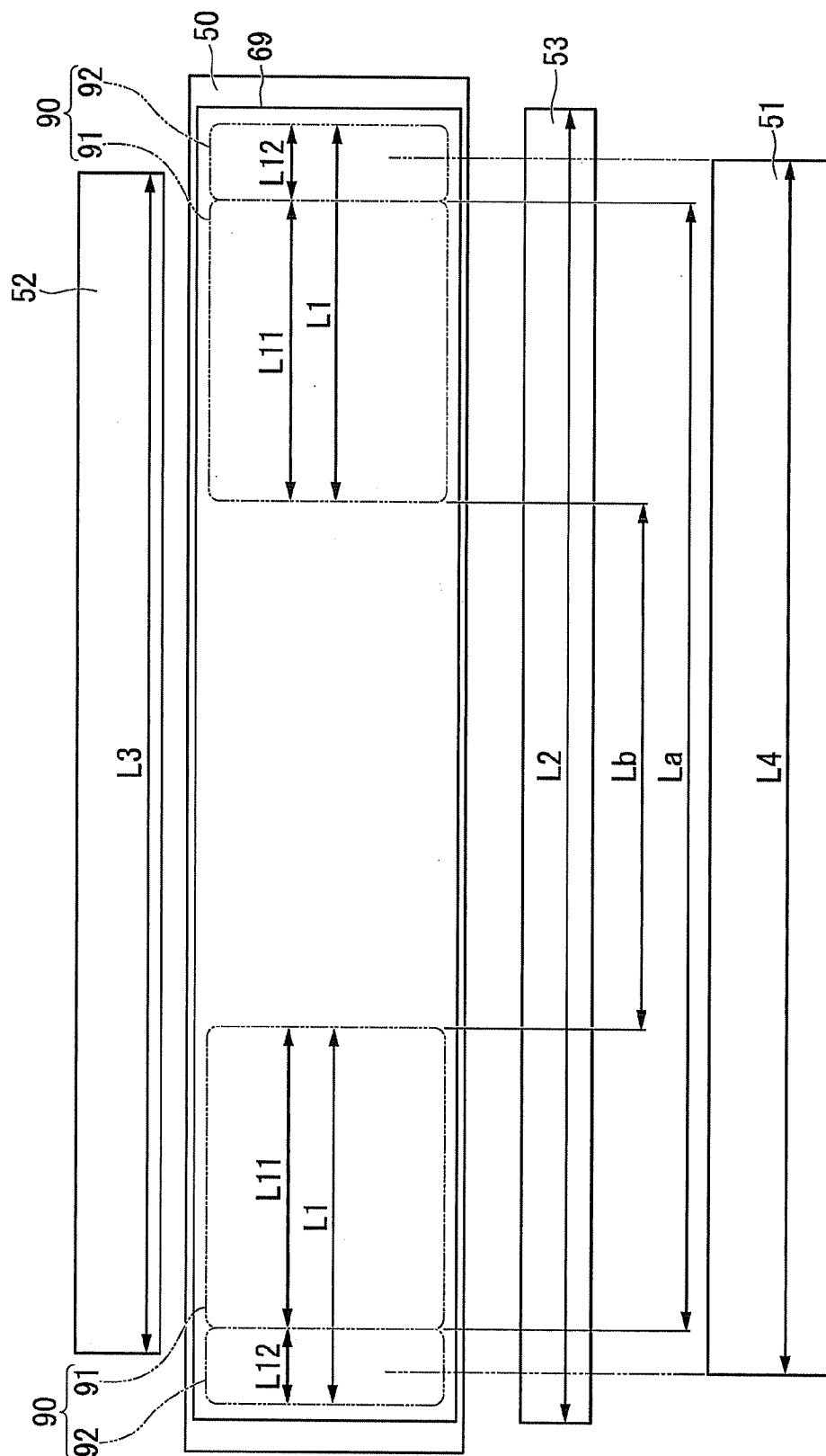


FIG. 8



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INDUCTION FIXING DEVICE WITH MAGNETIC MEMBER INCLUDING A MESH PART

FIELD

Embodiments described herein relate generally to a fixing device and an image forming apparatus.

BACKGROUND

Hitherto, there is an image forming apparatus such as a multi-function peripheral (hereinafter referred to as "MFP") or a printer. The image forming apparatus includes a fixing device. The fixing device heats a conductive layer of a fixing belt by an electromagnetic induction heating system (hereinafter referred to as "IH system"). The fixing device fixes a toner image to a recording medium by heat of the fixing belt. The conductive layer of the fixing belt generates heat by an induction current. In the fixing device, the heat capacity of the fixing belt is reduced in order to shorten a warming-up time and the like. The fixing device includes an auxiliary heat generation part in order to compensate insufficiency of the heat generation amount of the fixing belt. The auxiliary heat generation part concentrates magnetic flux at electromagnetic induction heating and increases the heat generation amount of the fixing belt. The auxiliary heat generation part is formed of a magnetic material. For example, the magnetic material is a magnetic shunt alloy. The magnetic characteristic of the magnetic shunt alloy changes according to temperature. The magnetic shunt alloy changes from ferromagnetic to paramagnetic at the Curie point. The magnetic shunt alloy generates heat by itself. There is a possibility that the magnetic shunt alloy loses magnetic properties, and the heating efficiency of the fixing belt is reduced.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of an image forming apparatus of an embodiment.

FIG. 2 is a side view of a fixing device including a control block of an IH coil unit of the embodiment.

FIG. 3 is a perspective view of the IH coil unit of the embodiment.

FIG. 4 is an explanatory view of magnetic paths formed by magnetic flux of the IH coil unit of the embodiment to a fixing belt and an auxiliary heat generation plate.

FIG. 5 is a block diagram showing a control system mainly concerning control of the IH coil unit of the embodiment.

FIG. 6 is an explanatory view of arrangement of a mesh part of the embodiment.

FIG. 7 is an enlarged view of the mesh part of the embodiment.

FIG. 8 is an explanatory view of lengths of the mesh part in a width direction of the fixing belt of the embodiment.

DETAILED DESCRIPTION

In general, according to one embodiment, a fixing device includes a fixing belt, an induction current generating part and an auxiliary heat generation part. The fixing belt includes a conductive layer. The induction current generating part faces the fixing belt in a thickness direction. The induction current generating part heats the conductive layer by electromagnetic induction. The auxiliary heat generation part faces the induction current generating part through the fixing belt. The auxiliary heat generation part includes a magnetic member. The

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magnetic member includes a mesh part. The mesh part has a mesh shape when viewed from the thickness direction of the fixing belt.

Hereinafter, an image forming apparatus 10 of an embodiment will be described with reference to the drawings. Incidentally, in the respective drawings, the same components are denoted by the same reference numerals.

FIG. 1 is a side view of the image forming apparatus 10 of the embodiment. Hereinafter, the MFP 10 will be described as an example of the image forming apparatus 10.

As shown in FIG. 1, the MFP 10 includes a scanner 12, a control panel 13, a paper feed cassette part 16, a paper feed tray 17, a printer part 18 and a paper discharge part 20. The MFP 10 includes a CPU 100 to control the whole MFP 10. The CPU 100 controls a main body control circuit 101 (see FIG. 2).

The scanner 12 reads a document image. The control panel 13 includes an input key 13a and a display part 13b. For example, the input key 13a receives an input from a user. For example, the display part 13b is of a touch panel type. The display part 13b receives the input from the user and displays to the user.

A paper feed cassette part 16 includes a paper feed cassette 16a and a pickup roller 16b. The paper feed cassette 16a contains a sheet P as a recording medium. The pickup roller 16b takes out the sheet P from the paper feed cassette 16a.

The paper feed cassette 16a feeds the unused sheet P. The paper feed tray 17 feeds the unused sheet P by a pickup roller 17a.

A printer part 18 forms an image from the document image read by the scanner 12. The printer part 18 includes an intermediate transfer belt 21. In the printer part 18, the intermediate transfer belt 21 is supported by a backup roller 40, a driven roller 41 and a tension roller 42. The backup roller 40 includes a drive part (not shown). In the printer part 18, the intermediate transfer belt 21 rotates in an arrow m direction.

The printer part 18 includes four sets of image forming stations 22Y, 22M, 22C and 22K. The respective image forming stations 22Y, 22M, 22C and 22K are for forming images of Y (Yellow), M (Magenta), C (Cyan) and K (black). The image forming stations 22Y, 22M, 22C and 22K are arranged under the intermediate transfer belt 21 and in parallel along the rotation direction of the intermediate transfer belt 21.

The printer part 18 includes cartridges 23Y, 23M, 23C and 23K above the respective image forming stations 22Y, 22M, 22C and 22K. The cartridges 23Y, 23M, 23C and 23K respectively contain replenishing toners of Y (Yellow), M (Magenta), C (Cyan) and K (black).

Hereinafter, the description is made while the image forming station 22Y is used as an example among the image forming stations 22Y, 22M, 22C and 22K. Since the image forming stations 22M, 22C and 22K have the same structure as the image forming station 22Y, the detailed description thereof is omitted.

The image forming station 22Y includes a charging charger 26, an exposure scanning head 27, a developing device 28 and a photoconductive cleaner 29. The charging charger 26, the exposure scanning head 27, the developing device 28 and the photoconductive cleaner 29 are arranged around a photoconductive drum 24 rotating in an arrow n direction.

The image forming station 22Y includes a primary transfer roller 30. The primary transfer roller 30 faces the photoconductive drum 24 through the intermediate transfer belt 21.

The image forming station 22Y charges the photoconductive drum 24 by the charging charger 26, and then exposes the photoconductive drum by the exposure scanning head 27. The

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image forming station 22Y forms an electrostatic latent image on the photoconductive drum 24. The developing device 28 uses a two-component developer made of toner and carrier, and develops the electrostatic latent image on the photoconductive drum 24.

The primary transfer roller 30 primarily transfers a toner image formed on the photoconductive drum 24 to the intermediate transfer belt 21. The image forming stations 22Y, 22M, 22C and 22K form a color toner image on the intermediate transfer belt 21 by the primary transfer rollers 30. The color toner image is formed by sequentially superimposing the Y (Yellow), M (Magenta), C (Cyan) and K (black) toner images. The photoconductive cleaner 29 removes toner remaining on the photoconductive drum 24 after the primary transfer.

The printer part 18 includes a secondary transfer roller 32. The secondary transfer roller 32 faces the backup roller 40 through the intermediate transfer belt 21. The secondary transfer roller 32 secondarily transfers the color toner image on the intermediate transfer belt 21 to the sheet P. The sheet P is fed from the paper feed cassette part 16 or the manual paper feed tray 17 along a conveyance path 33.

The printer part 18 includes a belt cleaner 43 facing the driven roller 41 through the intermediate transfer belt 21. The belt cleaner 43 removes toner remaining on the intermediate transfer belt 21 after the secondary transfer. Incidentally, the image forming part includes the intermediate transfer belt 21, the four sets of image forming stations (22Y, 22M, 22C and 22K) and the secondary transfer roller 32.

The printer part 18 includes a register roller 33a, a fixing device 34 and a paper discharge roller 36 along the conveyance path 33. The printer part 18 includes a branch part 37 and a reverse conveyance part 38 downstream of the fixing device 34. The branch part 37 sends the sheet P after fixing to the paper discharge part 20 or the reverse conveyance part 38. In the case of double-sided printing, the reverse conveyance part 38 reverses and conveys the sheet P sent from the branch part 37 toward the register roller 33a. The MFP 10 forms a fixed toner image on the sheet P by the printer part 18. The MFP 10 discharges the sheet P on which the fixed toner image is formed to the paper discharge part 20.

Incidentally, the MFP 10 is not limited to the tandem developing system. Besides, in the MFP 10, the number of the developing devices 28 is not limited. Besides, the MFP 10 may directly transfer the toner image to the sheet P from the photoconductive drum 24.

Hereinafter, the fixing device 34 will be described in detail.

FIG. 2 is a side view of the fixing device 34 including a control block of an electromagnetic induction heating coil unit 52 of the embodiment. Hereinafter, the electromagnetic induction heating coil unit will be referred to as "IH coil unit".

As shown in FIG. 2, the fixing device 34 includes a fixing belt 50, a press roller 51, the IH coil unit 52 and an auxiliary heat generation plate 69.

The fixing belt 50 is a tubular endless belt. A belt inner mechanism 55 including a nip pad 53 and the auxiliary heat generation plate 69 is arranged at the inner peripheral side of the fixing belt 50.

The fixing belt 50 is driven by the press roller 51 and rotates in an arrow u direction. Alternatively, the fixing belt 50 may be independent of the press roller 51 and may rotate in the arrow u direction. When the fixing belt 50 and the press roller 51 independently rotate, a one-way clutch may be provided in order to prevent a speed difference between the fixing belt 50 and the press roller 51 from occurring.

In the fixing belt 50, a heat generation layer 50a (conductive layer) as a heat generation part and a release layer 50c are

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sequentially laminated on a base layer 50b. Incidentally, the layer structure of the fixing belt 50 is not limited as long as the heat generation layer 50a is included.

For example, the base layer 50b is made of polyimide resin (P1). For example, the heat generation layer 50a is made of nonmagnetic metal such as copper (Cu). For example, the release layer 50c is made of fluorine resin such as tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer resin (PFA).

In the fixing belt 50, the heat generation layer 50a is made thin and the heat capacity is reduced in order to perform quick warming-up. The fixing belt 50 with the low heat capacity shortens the time necessary for warming-up. The time necessary for warming-up is shortened, so that energy consumption is saved.

For example, in the fixing belt 50, the thickness of the copper layer of the heat generation layer 50a is made 10 μm in order to reduce the heat capacity. For example, the heat generation layer 50a is covered with a protection layer of nickel or the like. The protection layer of nickel or the like suppresses oxidation of the copper layer. The protection layer of nickel or the like improves the mechanical strength of the copper layer.

Incidentally, the heat generation layer 50a may be formed such that electroless nickel plating is applied to the base layer 50b made of polyimide resin, and copper plating is applied. The electroless nickel plating is applied, so that adhesion strength between the base layer 50b and the heat generation layer 50a is improved. The electroless nickel plating is applied, so that the mechanical strength of the heat generation layer 50a is improved.

The surface of the base layer 50b may be roughened by sandblast or chemical etching. The surface of the base layer 50b is roughened, so that the adhesion strength between the base layer 50b and the nickel plating of the heat generation layer 50a is mechanically further improved.

A metal such as titanium (Ti) may be dispersed in the polyimide resin forming the base layer 50b. The metal is dispersed in the base layer 50b, so that the adhesion strength between the base layer 50b and the nickel plating of the heat generation layer 50a is further improved.

For example, the heat generation layer 50a may be made of nickel, iron (Fe), stainless, aluminum (Al), silver (Ag) or the like. The heat generation layer 50a may be made of two or more kinds of alloys, or two or more kinds of metals may be laminated.

The heat generation layer 50a generates eddy current by magnetic flux generated by the IH coil unit 52. The heat generation layer 50a generates Joule heat by the eddy current and electrical resistance of the heat generation layer 50a, and heats the fixing belt 50.

FIG. 3 is a perspective view of the IH coil unit 52 of the embodiment.

As shown in FIG. 3, the IH coil unit 52 includes a coil 56, a first core 57 and a second core 58.

The coil 56 generates magnetic flux by application of high-frequency current. The coil 56 faces the fixing belt 50 in the thickness direction. The longitudinal direction of the coil 56 is coincident with the width direction (hereinafter called "belt width direction") of the fixing belt 50.

The first core 57 and the second core 58 cover the opposite side (hereinafter called "back side") of the coil 56 to the fixing belt 50. The first core 57 and the second core 58 suppress the magnetic flux generated by the coil 56 from leaking to the back side. The first core 57 and the second core 58 concentrate the magnetic flux from the coil 56 to the fixing belt 50.

The first core 57 includes plural single wing parts 57a. The plural single wing parts 57a are alternately zigzag arranged

axial-symmetrically with respect to a center line **56d** along the longitudinal direction of the coil **56**.

The second cores **58** are arranged on both sides of the first core **57** in the longitudinal direction. The second core **58** includes plural both-wings parts **58a** extending over both wings of the coil **56**.

For example, the single wing part **57a** and the both-wings part **58a** are made of magnetic material such as nickel-zinc alloy (Ni—Zn) or manganese-nickel alloy (Mn—Ni).

The first core **57** regulates the magnetic flux generated by the coil **56** by the plural single wing parts **57a**. The magnetic flux generated by the coil **56** is alternately regulated in each single wing of the coil **56** axial-symmetrically with respect to the center line **56d**. The first core **57** concentrates the magnetic flux from the coil **56** to the fixing belt **50** by the plural single wing parts **57a**.

The second core **58** regulates the magnetic flux generated by the coil **56** by the plural both-wings parts **58a**. The magnetic flux generated by the coil **56** is regulated by both wings of the coil **56** on both sides of the first core **57**. The second core **58** concentrates the magnetic flux from the coil **56** to the fixing belt **50** by the plural both-wings parts **58a**. The magnetic flux concentration force of the second core **58** is larger than the magnetic flux concentration force of the first core **57**.

The coil **56** includes a first wing **56a** and a second wing **56b**. The first wing **56a** is arranged on one side with respect to the center line **56d**. The second wing **56b** is arranged on the other side with respect to the center line **56d**. A window part **56c** is formed between the first wing **56a** and the second wing **56b** and inside the coil **56** in the longitudinal direction.

As shown in FIG. 2, the IH coil unit **52** generates an induced current while the fixing belt **50** rotates in the arrow u direction. The heat generating layer **50a** of the fixing belt **50** facing the IH coil unit **52** generates heat by the induced current.

For example, a litz wire is used for the coil **56**. The litz wire is formed by bundling plural copper wires coated with heat-resistant polyamideimide as insulation material. The coil **56** is formed by winding a conductive coil.

The coil **56** generates the magnetic flux by application of high-frequency current from an inverter drive circuit **68**. For example, the inverter drive circuit **68** includes an IGBT (Insulated Gate Bipolar Transistor) element **68a**.

The auxiliary heat generation plate **69** is formed into an arc shape along the inner peripheral surface of the fixing belt **50**. The auxiliary heat generation plate **69** faces the first wing **56a** and the second wing **56b** of the coil **56** through the fixing belt **50**. The auxiliary heat generation plate **69** generates an eddy current by the magnetic flux generated by the IH coil unit **52** and generates heat. The auxiliary heat generation plate **69** assists the heat generation of the heat generating layer **50a** of the fixing belt **50** by the IH coil unit **52**. The auxiliary heat generation plate **69** assists heating of the fixing belt **50**. The auxiliary heat generation plate **69** is arranged in an area surrounded by the fixing belt **50**. The auxiliary heat generation plate **69** is arranged at an interval from the inner peripheral surface of the fixing belt **50**.

The auxiliary heat generation plate **69** is supported by a shield **76** from the side opposite to the coil **56**. The shield **76** is formed into an arc shape similar to the auxiliary heat generation plate **69**. The shield **76** is arranged on an inner peripheral side of the auxiliary heat generation plate **69**. For example, the shield **76** is made of non-magnetic material such as aluminum or copper. The shield **76** shields the magnetic flux from the IH coil unit **52**. The shield **76** suppresses the magnetic flux from influencing the nip pad **53** and the like.

The auxiliary heat generation plate **69** is formed of a magnetic member. For example, the magnetic member is a magnetic shunt alloy. The magnetic shunt alloy is an alloy of iron and nickel, whose Curie point is 220° C. to 230° C. The magnetic shunt alloy is a thin metal member. The auxiliary heat generation plate **69** loses magnetic properties when the temperature exceeds the Curie point, and heating assist to the fixing belt **50** weakens. Since the auxiliary heat generation plate **69** is made of the magnetic shunt alloy, the fixing belt **50** is heated within the range of heat-resistant temperature. The magnetic properties of the magnetic shunt alloy changes according to temperature. The magnetic shunt alloy changes from ferromagnetic to paramagnetic at the Curie point. The magnetic shunt alloy generates heat by itself. The magnetic shunt alloy loses the magnetic properties at the Curie point, and the heating assist to the fixing belt **50** weakens.

Incidentally, the auxiliary heat generation plate **69** may be formed of a thin metal member having magnetic properties, such as iron, nickel or stainless. Besides, the auxiliary heat generation plate **69** may be formed of a resin including magnetic powder as long as the magnetic properties are provided. Besides, the auxiliary heat generation plate **69** may be formed of a magnetic material (ferrite). The magnetic material (ferrite) promotes heat generation of the fixing belt **50** through magnetic flux generated by induced current. The magnetic material (ferrite) itself does not generate heat even if the magnetic flux generated by the induced current is applied. The auxiliary heat generation plate **69** is not limited to the thin plate member.

Besides, the auxiliary heat generation plate **69** may be provided with plural slits orthogonal to the direction of the current induced by the IH coil unit **52**. The plural slits are formed in the auxiliary heat generation plate **69**, so that the eddy current generated in the auxiliary heat generation plate **69** is divided. That is, the eddy current generated in the auxiliary heat generation plate **69** becomes the eddy current generated between the slits. Since the plural slits are formed in the auxiliary heat generation plate **69**, the magnitude of the eddy current generated between the slits can be decreased as compared with a case where the slits are not formed in the auxiliary heat generation plate **69**. The magnitude of the eddy current generated between the slits is decreased, so that the heat generation of the auxiliary heat generation plate **69** can be reduced.

Incidentally, the auxiliary heat generation plate **69** may contact the inner peripheral surface of the fixing belt **50**. When the auxiliary heat generation plate **69** contacts the inner peripheral surface of the fixing belt **50**, temperature difference between the auxiliary heat generation plate **69** and the fixing belt **50** is suppressed.

Both arc-shaped ends of the auxiliary heat generation plate **69** are supported by the belt inner mechanism **55**. For example, the belt inner mechanism **55** may cause the auxiliary heat generation plate **69** to approach or separate from the fixing belt **50**. For example, the auxiliary heat generation plate **69** may be separated from the fixing belt **50** before warming-up of the fixing device **34** and may approach the fixing belt **50** after warming-up.

FIG. 4 is an explanatory view of magnetic paths to the fixing belt **50** and the auxiliary heat generation plate **69**, which are formed by the magnetic flux of the IH coil unit **52** of the embodiment. Incidentally, in FIG. 4, for convenience, illustration of the coil **56** and the like is omitted.

As shown in FIG. 4, the magnetic flux generated by the IH coil unit **52** forms a first magnetic path **81** guided to the heat generating layer **50a** of the fixing belt **50**. The magnetic flux

generated by the IH coil unit **52** forms a second magnetic path **82** guided to the auxiliary heat generation plate **69**.

The auxiliary heat generation plate **69** generates heat by the magnetic flux generated by the IH coil unit **52**. The auxiliary heat generation plate **69** assists the heat generation of the heat generating layer **50a** of the fixing belt **50** at warming-up of the fixing belt **50** and accelerates the warming-up. The auxiliary heat generation plate **69** assists the heat generation of the heat generating layer **50a** of the fixing belt **50** at printing. The fixing temperature is kept by assisting the heat generation of the heat generating layer **50a** of the fixing belt **50**.

As shown in FIG. 2, the nip pad **53** is a press part to press the inner peripheral surface of the fixing belt **50** to the press roller **51** side. A nip **54** is formed between the fixing belt **50** and the press roller **51**.

For example, the nip pad **53** is made of elastic material such as silicone rubber or fluorine rubber. The nip pad **53** may be made of heat-resistant resin such as polyimide resin (PI), polyphenylene sulfide resin (PPS), polyethersulfone resin (PES), liquid crystal polymer (LCP) or phenol resin (PF).

For example, a sheet-shaped friction reducing member is arranged between the fixing belt **50** and the nip pad **53**. For example, the friction reducing member is formed of a sheet member excellent in sliding properties and in wear resistance and a release layer. The friction reducing member is fixedly supported by the belt inner mechanism **55**. The friction reducing member slidably contacts the inner peripheral surface of the running fixing belt **50**. The friction reducing member may be formed of a lubricating sheet member. The sheet member may be formed of a glass fiber sheet impregnated with fluorine resin.

For example, the press roller **51** includes a heat-resistant silicone sponge, a silicone rubber layer and the like around a core metal. For example, a release layer is arranged on the surface of the press roller **51**. The release layer is made of fluorine resin such as PFA resin. The press roller **51** pressurizes the fixing belt **50** by a pressurizing mechanism **51a**. The press roller **51**, together with the nip pad **53**, is a pressurizing part to pressurize the fixing belt **50**. The press roller **51** rotates in an arrow q direction by a motor **51b**. The motor **51b** is driven by a motor drive circuit **51c** controlled by the main body control circuit **101**.

A center thermistor **61**, an edge thermistor **62** and a thermostat **63** are arranged in an area surrounded by the fixing belt **50**.

The center thermistor **61** and the edge thermistor **62** detect the temperature of the fixing belt **50**. The center thermistor **61** and the edge thermistor **62** input the detection result of the temperature of the fixing belt **50** to the main body control circuit **101**. The center thermistor **61** is arranged at the center of the fixing belt **50** in the width direction.

The edge thermistor **62** is arranged outside the IH coil unit **52** in the belt width direction. The edge thermistor **62** is not influenced by the IH coil unit **52**, and detects the outside temperature of the fixing belt **50** in the belt width direction at high precision.

The main body control circuit **101** controls an IH control circuit **67** according to the detection result of the center thermistor **61** and the edge thermistor **62**. The IH control circuit **67** controls the high-frequency current outputted by the inverter drive circuit **68** by the control of the main body control circuit **101**. The fixing belt **50** keeps various control temperature ranges according to the output of the inverter drive circuit **68**.

The thermostat **63** functions as a safety device of the fixing device **34**. The thermostat **63** operates when the fixing belt **50** abnormally generates heat and the temperature rises up to an

interruption threshold. The current to the IH coil unit **52** is interrupted by the operation of the thermostat **63**. Driving of the MFP **10** is stopped by the interruption of the current to the IH coil unit **52**. By the stop of driving, the MFP **10** suppresses the fixing device **34** from abnormally generating heat.

Hereinafter, the main part of the fixing device **34** of the embodiment will be described with reference to FIG. 6 and FIG. 7.

FIG. 6 is an explanatory view of arrangement of a mesh part **90** of the embodiment. FIG. 7 is an enlarged view of the mesh part **90** of the embodiment.

As shown in FIG. 6 and FIG. 7, the auxiliary heat generation plate **69** (magnetic shunt alloy) includes the mesh part **90**. The magnetic shunt alloy includes the mesh part **90**. The mesh part **90** is formed of the magnetic shunt alloy. The mesh part **90** has a mesh shape when viewed from the thickness direction of the fixing belt **50**. The mesh part **90** has a honeycomb shape when viewed from the thickness direction of the fixing belt **50**. The mesh part **90** includes plural opening parts **90h** opening when viewed from the thickness direction of the fixing belt **50**. The plural opening parts **90h** are arranged in a lattice form when viewed from the thickness direction of the fixing belt **50**. The opening part **90h** has a hexagonal shape when viewed from the thickness direction of the fixing belt **50**. The two adjacent opening parts **90h** shift from each other in the belt width direction.

An interval **s1** between the two adjacent opening parts **90h** is two or more times the thickness of the auxiliary heat generation plate **69**. The interval **s1** means the length of a line connecting edge parts **90e** of the two adjacent opening parts **90h**. The edge part **90e** includes six sides of the hexagon when viewed from the thickness direction of the fixing belt **50**. For example, the thickness of the auxiliary heat generation plate **69** is about 0.15 mm.

For example, a size **d1** of the opening part **90h** is about 0.4 to 0.5 mm. The size **d1** of the opening part **90h** means the length of a line connecting the two edge parts **90e** facing each other in the opening part **90h**.

Hereinafter, an area **AR1** through which the sheet P passes is called a "paper passing area". An area through which the sheet P does not pass is called a "non-paper passing area". An area **AR2** adjacent to the paper passing area **AR1** in the belt width direction is called an "area".

As shown in FIG. 6, the paper passing area **AR1** is positioned at the center of the fixing belt **50** in the belt width direction. The area **AR2** is positioned at both end parts of the fixing belt **50** in the belt width direction.

The area **AR2** includes a first area **AR21** and a second area **AR22**. The first area **AR21** and the second area **AR22** are arranged side by side in the width direction of the fixing belt **50**. The first area **AR21** is closer to the paper passing area **AR1** than the second area **AR22**. The first area **AR21** is adjacent to the paper passing area **AR1**. The second area **AR22** is adjacent to the first area **AR21**.

Hereinafter, the sheet P having the largest length in the belt width direction among the sheets P used is called a "large sheet". Besides, the sheet P having the smallest length in the belt width direction among the sheets P used is called a "small sheet". A length **La** of the large sheet in the belt width direction is called a "large sheet width". A length **Lb** of the small sheet in the belt width direction is called a "small sheet width".

For example, the large sheet width **La** is the same as the short side width of an A3 sheet. For example, the small sheet width **Lb** is the same as the short side width of an A4 sheet (hereinafter called "A4R width"). The small sheet width **Lb** may be made the same as the short side width of a postcard.

The large sheet width L_a and the small sheet width L_b may be changed according to the design specification of the fixing device 34.

Hereinafter, the length of the paper passing area AR1 in the belt width direction is called a “paper passing area width”. The length of the area AR2 in the belt width direction is called an “area width”. The length of the first area AR21 in the belt width direction is called a “first area width”. The length of the second area AR22 in the belt width direction is called a “second area width”.

For example, the paper passing area width is the same as the small sheet width L_b . The area width is the addition of the first area width and the second area width. The first area width is the size obtained by subtracting the small sheet width L_b from the large sheet width L_a .

For example, the area AR2 is the area through which the small sheet does not pass. For example, the first area AR21 is the area through which the large sheet passes. For example, the first area AR21 is the area through which the small sheet does not pass. For example, the second area AR22 is the area through which the large sheet and the small sheet do not pass. The second area AR22 is the non-paper passing area.

The mesh parts 90 are positioned at both the end parts of the fixing belt 50 in the belt width direction. The mesh part 90 faces the area AR2 in the belt width direction. The mesh part 90 does not face the paper passing area AR1 in the belt width direction.

The mesh part 90 includes a first mesh part 91 and a second mesh part 92. The first mesh part 91 faces the first area AR21 in the belt width direction. The second mesh part 92 faces the second area AR22 in the belt width direction. The first mesh part 91 is adjacent to the paper passing area AR1 of the auxiliary heat generation plate 69. The second mesh part 92 is adjacent to the first mesh part 91.

For example, the porosity of the mesh part 90 is larger than 0% and not larger than 50%. The porosity means the ratio of an open area of the opening part 90h to a unit area of the auxiliary heat generation plate 69.

The porosities of the first mesh part 91 and the second mesh part 92 are different from each other. The porosity of the second mesh part 92 is larger than the porosity of the first mesh part 91. As the porosity becomes large, the ratio of the edge part 90e of the opening part 90h to the unit area of the auxiliary heat generation plate 69 becomes large. For example, the porosity of the first mesh part 91 is about 10 to 30%. For example, the porosity of the second mesh part 92 is about 30 to 50%. For example, the size of the opening part 92h of the second mesh part 92 is the same as the size of the opening part 91h of the first mesh part 91. For example, the number of the opening parts 92h of the second mesh part 92 is larger than the number of the opening parts 91h of the first mesh part 91.

The size of the opening part 92h of the second mesh part 92 may be different from the size of the opening part 91h of the first mesh part 91. Besides, the number of the opening parts 92h of the second mesh part 92 may be smaller than the number of the opening parts 91h of the first mesh part 91. That is, the porosity of the second mesh part 92 has only to be larger than the porosity of the first mesh part 91.

FIG. 8 is an explanatory view of a length L_1 of the mesh part 90 in the belt width direction of the embodiment.

Hereinafter, the length L_1 of the mesh part 90 in the belt width direction is called a “mesh part width”. A length L_{11} of the first mesh part 91 in the belt width direction is called a “first mesh part width”. A length L_{12} of the second mesh part 92 in the belt width direction is called a “second mesh part width”.

As shown in FIG. 8, the mesh part width L_1 is the addition of the first mesh part width L_{11} and the second mesh part width L_{12} . For example, the mesh part width L_1 is the same as the area width. For example, the first mesh part width L_{11} is the same as the first area width. For example, the second mesh part width L_{12} is the same as the second area width.

Hereinafter, a length L_2 of the nip pad 53 in the belt width direction is called a “nip pad width”. A length L_3 of the IH coil unit 52 in the belt width direction is called an “IH coil unit width”. A length L_4 of the press roller 51 in the belt width direction is called a “press roller width”.

For example, the nip pad width L_2 , the IH coil unit width L_3 , the press roller width L_4 , the large sheet width L_a and the small sheet width L_b have a relation of following equation (1).

$$L_2 \geq L_4 > L_3 > L_a > L_b \quad \text{equation (1)}$$

Hereinafter, the control system 110 of the IH coil unit 52 for heating the fixing belt 50 will be described in detail.

FIG. 5 is a block diagram showing the control system 110 mainly concerning the control of the IH coil unit 52 of the embodiment.

As shown in FIG. 5, the control system 110 includes the CPU 100, a read only memory (ROM) 100a, a random access memory (RAM) 100b, the main body control circuit 101, an IH circuit 120 and the motor drive circuit 51c.

The control system 110 supplies power to the IH coil unit 52 by the IH circuit 120. The IH circuit 120 includes a rectifier circuit 121, the IH control circuit 67, the inverter drive circuit 68 and a current detection circuit 122.

Current is inputted to the IH circuit 120 from an AC power supply 111 through a relay 112. The IH circuit 120 rectifies the inputted current by the rectifier circuit 121 and supplies the current to the inverter drive circuit 68. The relay 112 interrupts the current from the AC power supply 111 when the thermostat 63 is turned off. The inverter drive circuit 68 includes a drive IC 68b of an IGBT element 68a and a thermistor 68c. The thermistor 68c detects the temperature of the IGBT element 68a. When the thermistor 68c detects the temperature rise of the IGBT element 68a, the main body control circuit 101 drives a fan 102 and cools the IGBT element 68a.

The IH control circuit 67 controls the drive IC 68b according to the detection result of the center thermistor 61 and the edge thermistor 62. The IH control circuit 67 controls the drive IC 68b and controls the output of the IGBT element 68a. The current detection circuit 122 sends the detection result of the output of the IGBT element 68a to the IH control circuit 67. The IH control circuit 67 controls the drive IC 68b based on the detection result of the current detection circuit 122 so that power supplied to the coil 56 becomes constant.

Hereinafter, an operation of the fixing device 34 at warming-up will be described.

As shown in FIG. 2, at the warming-up, the fixing device 34 rotates the press roller 51 in the arrow q direction, and the fixing belt 50 is driven and rotated in the arrow u direction. The IH coil unit 52 generates magnetic flux at the fixing belt 50 side by application of the high-frequency current by the inverter drive circuit 68.

As shown in FIG. 4, the magnetic flux of the IH coil unit 52 is guided to the first magnetic path 81 passing through the heat generation layer 50a of the fixing belt 50, and heats the heat generation layer 50a. The magnetic flux of the IH coil unit 52 passing through the fixing belt 50 is guided to the second magnetic path 82 passing through the auxiliary heat generation plate 69, and heats the auxiliary heat generation plate 69. Heating of the heat generation layer 50a is assisted by the

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second magnetic path **82** formed between the heat generation layer **50a** and the auxiliary heat generation plate **69**.

As shown in FIG. 2, the IH control circuit **67** controls the inverter drive circuit **68** based on the detection result of the center thermistor **61** or the edge thermistor **62**. The inverter drive circuit **68** supplies the high-frequency current to the coil **56**.

Hereinafter, an operation of the fixing device **34** at a fixing operation will be described.

After the fixing belt **50** reaches the fixing temperature and the warming-up is ended, when a print request occurs, the MFP **10** (see FIG. 1) starts a print operation. In the MFP **10**, the printer part **18** forms a toner image on the sheet P, and the sheet P is conveyed to the fixing device **34**.

In the MFP **10**, the sheet P on which the toner image is formed passes through the nip **54** between the fixing belt **50** whose temperature reaches the fixing temperature and the press roller **51**. The fixing device **34** fixes the toner image to the sheet P. While the fixing is performed, the IH control circuit **67** controls the IH coil unit **52**, and keeps the fixing belt **50** at the fixing temperature.

The heat of the fixing belt **50** is taken by the sheet P in the fixing operation. For example, when sheets are continuously passed at high speed, the heat is excessively taken by the sheets P, and the fixing belt **50** with low heat capacity may not keep the fixing temperature. The heat conduction from the auxiliary heat generation plate **69** to the fixing belt **50** heats the fixing belt **50** from the inner peripheral side of the fixing belt **50**, and compensates the insufficiency of the belt heat generation amount. The heating of the fixing belt **50** by the auxiliary heat generation plate **69** keeps the temperature of the fixing belt **50** at the fixing temperature even at high-speed continuous paper passing.

In order to shorten the warming-up time and the like, the heat capacity of the fixing belt **50** is small as compared with a case where the warming-up time is not shortened. The fixing belt **50** obtains the sufficient heat amount for fixing of the sheet P by the heat directly generated by the magnetic flux of the IH coil unit **52** and by the auxiliary heating provided by the second magnetic path **82**. According to the size of the sheet P, an area through which the sheet P pass and an area through which the sheet P does not pass occur in the fixing belt **50**. Hereinafter, a case where a sheet having an A4R width or a width smaller than the A4R width passes is called "small size paper passing time". A case where an A3 sheet passes is called "large size paper passing time". When the fixing operation is continued at the small size paper passing time, the temperature in the paper passing area **AR1** of the fixing belt **50** decreases, and the temperature in the area **AR2** rises.

According to the first embodiment, the auxiliary heat generation plate **69** includes the magnetic shunt alloy as the magnetic member. The auxiliary heat generation plate **69** (magnetic shunt alloy) includes the mesh part **90**. The mesh part **90** has the mesh shape when viewed from the thickness direction of the fixing belt **50**. The mesh part **90** generates heat by concentration of the magnetic flux to the mesh part **90**, so that self-heat generation of the magnetic shunt alloy is promoted. The magnetic shunt alloy loses the magnetic properties at the Curie point and the heating assist to the fixing belt **50** weakens. The heat generation of the mesh part **90** promotes that the temperature of the magnetic shunt alloy exceeds the Curie point. When the temperature of the magnetic shunt alloy is promoted to exceed the Curie point, the second magnetic path **82** becomes liable to disappear. Thus, the excessive increase of the belt heat generation amount is suppressed. When the excessive increase of the belt heat

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generation amount is suppressed, reduction of heating efficiency of the fixing belt **50** can be suppressed.

The mesh part **90** faces the area **AR2** in the belt width direction. The small sheet does not pass through the area **AR2**. Since the mesh part **90** faces the area **AR2** in the belt width direction, the temperature of the magnetic shunt alloy is promoted to exceed the Curie point at the small size paper passing time. Since the temperature of the magnetic shunt alloy is promoted to exceed the Curie point at the small size paper passing time, excessive temperature rise of the area **AR2** of the fixing belt **50** is suppressed.

The mesh part **90** includes the first mesh part **91** and the second mesh part **92**. The first mesh part **91** faces the first area **AR21** in the belt width direction. The second mesh part **92** faces the second area **AR22** in the belt width direction. The porosity of the second mesh part **92** is larger than the porosity of the first mesh part **91**. The porosity of the second mesh part **92** is larger than the porosity of the first mesh part **91**, and the ratio of the edge part of the opening part **92h** in the second mesh part **92** is larger than the ratio of the edge part of the opening part **91h** in the first mesh part **91**. The magnetic flux concentrates on the edge part **90e** of the opening part **90h**. As the ratio of the edge part **90e** of the opening part **90h** becomes large, the magnetic flux becomes liable to concentrate on the mesh part **90**. As the ratio of the edge part **90e** of the opening part **90h** becomes large, the mesh part **90** becomes liable to generate heat. Since the ratio of the edge part of the opening part **92h** in the second mesh part **92** is larger than the ratio of the edge part of the opening part **91h** in the first mesh part **91**, the second mesh part **92** is liable to generate heat. The large sheet and the small sheet do not pass through the second area **AR22**. Since the second mesh part **92** faces the second area **AR22** in the belt width direction, the temperature of the magnetic shunt alloy is promoted to exceed the Curie point at the large size paper passing time and the small size paper passing time. Since the temperature of the magnetic shunt alloy is promoted to exceed the Curie point at the large size paper passing time and the small size paper passing time, the excessive temperature rise of the second area **AR22** of the fixing belt **50** is suppressed.

The mesh part **90** includes the plural opening parts **90h** opening when viewed from the thickness direction of the fixing belt **50**. The two adjacent opening parts **90h** shift from each other in the belt width direction. Since the two adjacent opening parts **90h** shift from each other in the belt width direction, the magnetic flux flowing in the belt width direction becomes liable to concentrate on the edge part **90e** of the opening part **90h**. Since the magnetic flux becomes liable to concentrate on the edge part **90e**, the mesh part **90** becomes liable to generate heat. Since the mesh part **90** becomes liable to generate heat, the belt heat generation amount becomes liable to be sufficiently kept.

The interval **s1** between the two adjacent opening parts **90h** is two or more times the thickness of the auxiliary heat generation plate **69**. As compared with a case where the interval **s1** is less than two times the thickness of the auxiliary heat generation plate **69**, the strength of the mesh part **90** is improved. Besides, the formability of the mesh part **90** is improved. For example, the mesh part **90** is easily formed by punching process such as punch press. Incidentally, the mesh part **90** may be formed and shaped by chemical etching.

The porosity of the mesh part **90** is larger than 0% and not larger than 50%. As compared with a case where the porosity of the mesh part **90** exceeds 50%, the function as the auxiliary heat generation plate **69** (magnetic shunt alloy) is secured in the mesh part **90**.

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The paper passing area AR1 is positioned at the center of the fixing belt 50 in the belt width direction. The area AR2 is positioned at both the end parts of the fixing belt 50 in the belt width direction. The mesh part 90 is positioned at both the end parts of the fixing belt 50 in the belt width direction. The mesh part 90 faces the area AR2 in the belt width direction. The mesh part 90 does not face the paper passing area AR1 in the belt width direction. In the center-fixed fixing system, reduction of heating efficiency of the fixing belt 50 can be suppressed.

Hereinafter, modified examples of the embodiment will be described.

In the fixing device 34 of the embodiment, the paper passing area AR1 may be positioned at a first end part of both the end parts of the fixing belt 50 in the belt width direction. The area AR2 may be positioned at a second end part of both the end parts of the fixing belt 50 in the belt width direction. The mesh part 90 may be positioned at the second end part of both the end parts of the fixing belt 50 in the belt width direction. In the side-fixed fixing system, reduction of heating efficiency of the fixing belt 50 can be suppressed.

Incidentally, the opening part 90h may have a polygonal shape other than a hexagon, such as a triangle or a square, when viewed from the thickness direction of the fixing belt 50. Besides, the opening part 90h may have a circular shape or an elliptical shape when viewed from the thickness direction of the fixing belt 50. Besides, the opening part 90h may have a U-shape or a V-shape when viewed from the thickness direction of the fixing belt 50. That is, the opening part 90h has only to have the edge part 90e to concentrate the magnetic flux.

According to at least one embodiment described above, the auxiliary heat generation plate 69 includes the magnetic shunt alloy as the magnetic member. The auxiliary heat generation plate 69 (magnetic shunt alloy) includes the mesh part 90. The mesh part 90 has the mesh shape when viewed from the thickness direction of the fixing belt 50. The mesh part 90 generates heat by the magnetic flux concentration to the mesh part 90, and the self-heat generation of the magnetic shunt alloy is promoted. The magnetic shunt alloy loses the magnetic properties at the Curie point, and the heating assist to the fixing belt 50 weakens. The heat generation of the mesh part 90 promotes that the temperature of the magnetic shunt alloy exceeds the Curie point. Since the second magnetic path 82 becomes liable to disappear by promoting that the temperature of the magnetic shunt alloy exceeds the Curie point, the excessive increase of the belt heat generation amount is suppressed. The reduction of the heating efficiency of the fixing belt 50 can be suppressed by suppressing the excessive increase of the belt heat generation amount.

While certain embodiments have been described these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms: furthermore various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

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What is claimed is:

1. A fixing device comprising:

a fixing belt including a conductive layer;

an induction current generating part which faces the fixing belt in a thickness direction and heats the conductive layer by electromagnetic induction; and

an auxiliary heat generation part which faces the induction current generating part through the fixing belt and includes a magnetic member, in which

the magnetic member includes a mesh part having a mesh shape when viewed from the thickness direction of the fixing belt, the mesh part having a plurality of opening parts opening when viewed from the thickness direction of the fixing belt, wherein the auxiliary heat generation part assists heating the conductive layer.

2. The device according to claim 1, wherein the mesh part faces an area adjacent to a paper passing area in the width direction of the fixing belt.

3. The device according to claim 2, wherein

the area adjacent to the paper passing area includes a first area and a second area arranged side by side in the width direction of the fixing belt, and

the mesh part includes a first mesh part facing the first area in the width direction of the fixing belt and a second mesh part facing the second area in the width direction of the fixing belt.

4. The device according to claim 3, wherein

when a sheet having a large length in the width direction of the fixing belt is called a large sheet, and a sheet having a small length in the width direction of the fixing belt is called a small sheet,

the first area is an area through which the large sheet passes and the small sheet does not pass, and the second area is an area through which the large sheet and the small sheet do not pass.

5. The device according to claim 3, wherein a porosity of the first mesh part and a porosity of the second mesh part are different from each other.

6. The device according to claim 3, wherein

the first area is closer to the paper passing area than the second area in the width direction of the fixing belt, and a porosity of the second mesh part is larger than a porosity of the first mesh part.

7. The device according to claim 1, wherein

two adjacent opening parts of the plurality of opening parts shift from each other in the width direction of the fixing belt.

8. The device according to claim 1, wherein

an interval between two adjacent opening parts of the plurality of opening parts is two or more times a thickness of the auxiliary heat generation part.

9. The device according to claim 1, wherein a porosity of the mesh part is larger than 0% and not larger than 50%.

10. An image forming apparatus comprising:

an image forming part to form an image on a recording medium; and

a fixing device according to claim 1 for fixing the image to the recording medium.

11. The device according to claim 1, wherein the auxiliary heat generation part faces the induction current generating part through the conductive layer.

12. The device according to claim 1, further comprising:

a magnetic path formed between the conductive layer and the auxiliary heat generation part.

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